Controlaire

"Mule Tone Transmitter"

All Transistor 9 Volt Operation

Introduction

Advancements in transistor technology has made possible the production of this transmitter in kit form. The RF oscillator and power amplifier employ the new silicon planar 2N-706 transistors and their uniformity coupled with precision circuitry gives most satisfying results. About the only main requirement is that the builder exercise common sense during construction.

The instructions are presented in two separate manuals and a small pamphlet titled "Kit Assembly Tips" One manual is the standard "Operating Instructions" as supplied with factory assembled units and the other manual is the "Assembly Instructions" which you are now reading. It is of primary importance that before any assembly work is started that you initially read all three of these items to gain a preliminary understanding of all information involved.

As you study the manual you will notice that assembly is outlined by the step by step procedure and large pictorials which identify all parts and their exact placement to the circuit board. To understand the assembly procedure take notice of the main pictorial, Fig. 2. This is the pictorial about which the assembly text is centered. Notice that this is a top view of the transmitter chassis and that all componants are assigned specific hole numbers. The shaded area represents the etched copper circuit pattern and although on the underside of the Board, the same pattern can be recognized on the transmitter board by holding it up to a light source where the pattern will show through. By using the light on the actual transmitter board specific holes can be identified by association with the pattern or individual copper lands as shown in the pictorial.

Assembly of parts to the circuit board is quite conventional. Resistors and most other parts are mounted flush or upright as directed, however, if any specific positioning is required it will be mentioned in the step in which it is installed. As each part is installed bend its leads over slightly to hold it in position and then, after soldering, clip off the excess lead about 1/16" from the circuit copper.

Preliminary Notes

After you have studied the pictorials and initially read all of the instructions, unpack your kit carefully and check each part as identified on the check list. By doing this you will become familiar with parts appearance that will help you during assembly. After the check has been made, group the parts, resistors, in one pile, condensers in another, until parts are generally separated for easy identification.

Occasionally we may have to substitute a part to allow an even production of kits when a specific part is not available. This is done to prevent a delay in filling your order and in no way will the substitution effect normal operation. If this has been done in your kit a note, "Parts Substitution", will be included for your identification.

The use of the "Unger soldering pencil" equipped with 37½ watt heat element and small chisel pointed tip is considered mandatory in the construction of this kit. Similar irons may be used but none larger and of higher heat. The work on the etched circuit board is somewhat delicate so let a word to the wise be sufficient. If you do not have the small iron it should be purchased at your local radio or hardware store.

Common tools required are a small pair of dykes (wire snippers), long nose pliers, screwdriver, penknife, file, pad of steel wool. Other items are a hexagon shaped tuning tool and a 0-100 ma meter to be used for tuning purposes. The meter is available from World Engines for $4.95 and the tool at 50c.

Start construction by referring to the assembly steps. During each step refer to the pictorials for necessary parts location and solder the lead of each part as it is installed.

Place a check mark in the space provided after completion of each step. Good luck and may your experience be a pleasant one.

Assembly Instructions

As parts are installed to the circuit board, bend over the leads only enough to hold the parts in place, then solder, unless otherwise noted in text. Do not flush bend lead to the circuit copper as, if removal is necessary, it cannot be done without damage to the part. After soldering, clip off excess leads about 1/16" from circuit copper.

1. (✓) Using steel wool, vigorously scrub circuit copper to remove photo resist material so soldering can be easily accomplished. Scrub until copper is bright and shiny.

2. (✓) Prepare the push-button switch for mounting by first bending the tabs so they fit properly into circuit board slots 32 and 33. Next, disassemble the switch by removing the two hold-down screws and discard the metal plate that was installed directly under the screw heads. Reassemble the switch to the circuit board by inserting screws through holes 29 and 30. Align the switch so it is parallel with bottom edge of circuit board and tighten screws moderately.

3. (✓) Install a 4/40 x 5/16" binder head screw, nut and lockwasher to the antenna mount bracket as shown. When tightening do not apply a twisting torque to bracket without support as this can loosen the attaching eyelets.

4. (✓) Solder eyelet at hole 40 to both the circuit copper and antenna mount bracket to insure proper electrical contact. Do not allow a pile up of solder on the bracket as this will prevent proper antenna attaching clearance when it is installed later on.

5. (✓) Cut the respective leads of the modulation transformer to the following lengths and strip ¼" insulation from the end of each lead. Red to 1½", Blue and Green to 2" and Black to 1¾'.

6. (✓) Oriente and install modulation transformer to circuit board with red lead extending through hole 26, black through hole 27 and green through hole 28. The blue lead remains on top of circuit board. Fasten transformer to board by means of two 4/40 x 5/16" binder head screws and nuts at mount holes 25 and 31. To properly space the transformer above the screw heads of the push-button switch, use fiber washers under each mount lug of the transformer. Heads of the transformer mount screws should be on copper side of board.

7. (✓) Insert and solder transformer leads to the following hole positions. Blue from top of board to hole 36, black from bottom of board to hole 60, green from bottom to hole 59 and red from bottom to hole 66.

8. (✓) Insert a 4.7K ohm resistor (yellow, violet, red) in holes 16 and 17.

9. (✓) Insert a 27K ohm resistor (red, purple, orange) in holes 9 and 10.

10. (✓) Insert a 180 ohm resistor (brown, grey, brown) in holes 11 and 12.

11. (✓) Insert a 2.2K ohm resistor (red, red, red) in holes 57 and 58.

12. (✓) Insert a 4.7K ohm resistor (yellow, violet, red) in holes 45 and 46.

13. (✓) Insert a ~~100K~~ 47K ohm resistor (~~brown, black, yellow~~) YELLOW V. O in holes 38 and 39.

14. (✓) Insert a .02 MF disc capacitor in holes 7 and 8.

15. (✓) Insert a .02 MF disc capacitor in holes 20 and 21.

16. (✓) Insert a .01 MF disc capacitor in holes 63 and 64.

17. (✓) Insert a .05 MF disc capacitor in holes 53 and 54.

18. (✓) Insert a 100 MMFD disc capacitor in holes 55 and 56.

19. (✓) Insert a 50 MMFD capacitor in holes 1 and 2.

20. (✓) Insert the R. F. C. choke in Holes 61 and 62.

20A (✓) Inspect the terminals of the RF slug tuned coil assembly. Note that one terminal has a red coding mark. Install the coil terminals into holes 3, 4, 5, 6 with red marked terminal inserting into hole 3.
the labels should be spaced about

21. (✓) Refer to Fig. 3 to identify transistor leads. Identify and install 4JX1C1132 transistor with emitter lead going into hole 44, base to hole 43 and collector to hole 42. Stand bottom of transistor about ⅛" away from surface of circuit board.

22. (✓) Again refer to Fig. 3. Install a 2N-706 transistor with emitter lead in hole 13. Base in hole 15 and collector in hole 14. Stand bottom of transistor about ¼" away from surface of circuit board.

23. (✓) Install the heat sink, which is a press fit, over the top of the remaining 2N-706 transistor. If the fit is too tight and trouble is encountered, use a screw driver to wedge the heat sink open by inserting it at its split side. Install the transistor with emitter lead going into hole 24, base to hole 23 and collector to hole 22.

24. (✓) Notice the eyelets installed at hole positions 48 through 52. To insure a positive electrical contact to the circuit copper solder each eyelet to the copper at its outside perimeter. Do not allow solder to flow within eyelet hole. To do so will prevent later installation of the slide switch.

25. (✓) Install the slide switch with its terminals going into eyelet holes 48 through 52. Push the terminals through the eyelets until they protrude exactly 1/32" above eyelets on top side of circuit board. Be sure that the switch is installed straight and parallel with respect to surface of circuit board. If it is crooked it will prevent proper installation of chassis into housing case. Soldering to the eyelets and switch terminals is done from the top of the board. Allow solder to flow into the eyelets thus securing the terminals.

26. (✓) Cut a piece of black wire to a length of 5" and strip ¼" insulation from each end. On one end crimp and solder the male battery snap. The other end is soldered to board at hole 35.

27. (✓) Cut a piece of red wire to a length of 3½" and strip ¼" insulation from each end. On one end crimp and solder the female battery snap. Solder other end to board at hole 65.

28. (✓) Insert leads of .47 MF tubular condenser in holes 34 and 37.

29. (✓) Insert the terminal pins of the crystal into holes 18 and 19. Do not push all the way in but rather allow pins to protrude only about 1/16" through copper. Solder quickly and avoid excessive heating.

30. (✓) At this point assembly of the circuit board is complete. To install board into the housing case place it in position then use two 4/40 x 5/16" binder head screws to secure the slide switch. Use a ⅜" nut and washer to secure the push switch.

31. (✓) Fit rubber grommet to hole in top of transmitter case The antenna is then passed through grommet and threaded down on the antenna bracket screw.

General Information

This completes assembly of your transmitter. At this time it must be tuned. In accordance with docket 12902 of the Federal Communications Commission, the tuning adjustment of this transmitter must be made either under the direct supervision of, or by, a person holding a valid commercial radio operators license. You, personally, are not allowed to make this adjustment unless you hold a valid license as stated above. This may create some minor problem but usually in a radio control area such a person can be located. It is a matter of contacting your R/C acquaintances for such information. If you cannot locate a valid licensee you may return your completed unit to the factory for this service. Fee for tuning transmitter is $2.00 plus return postage. This does not include repair service if required. Before any attempt is made to tune or operate this transmitter the standard Mule operating instructions should be read.

MULE

PARTS CHECK AND PRICE LIST

Hardware

		Price Each
[ ]	1 ea. Transmitter Case Front and Back	$2.95
[ ]	1 ea. D.P.D.T. Slide Switch	.50
[ ]	1 ea. Push Switch	.75
[ ]	6 ea. No. 6 x ¼" S.M. Screws	.02
[ ]	5 ea. 4/40 x 5/16" B. H. Screws	.01
[ ]	3 ea. 4/40 Nuts and Lockwasher	.01
[ ]	4 ea. Fiber Washers	.01
[ ]	2 ea. Battery Snaps, Male and Female	.12
[ ]	1 ea. ⅜" Nut and Washer	.04
[ ]	1 ea. Transistor Heat Sink	.65
[ ]	1 ea. ½" Rubber Grommet	.03

Resistors

[ ]	1 ea. 180 ohm (brown, grey, brown)	.10
[ ]	2 ea. 4.7K ohm (yellow, violet, red)	.10
[ ]	1 ea. 2.2 K ohm (red, red, red)	.10
[ ]	1 ea. 27K ohm (red, purple, orange)	.10
[ ]	1 ea. 47K ohm (brown, black, yellow)	.10

Transformers, Coil, Choke

[ ]	1 ea. Modulation Transformer	1.90
[ ]	1 ea. RF Coil Assy.	1.90
[ ]	1 ea. RF Choke	.35

Wiring

[ ]	1 ea. 6" Length No. 22 Black	.01
[ ]	1 ea. 4" Length No. 22 Red	.01

Transistors

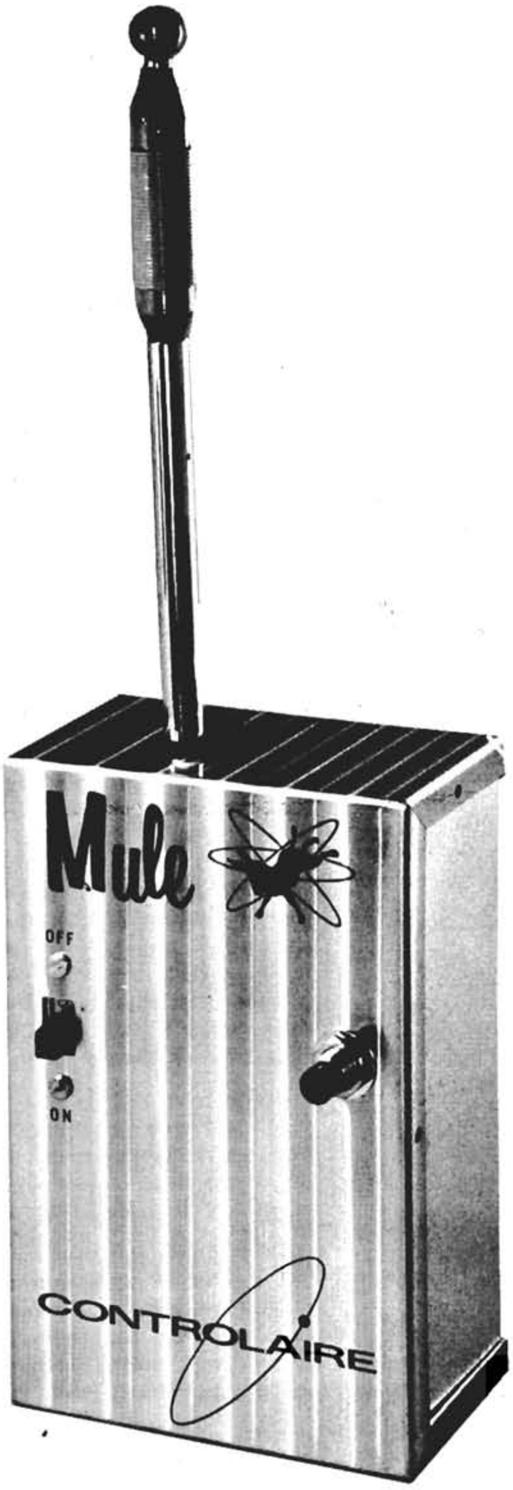
[ ]	2 ea. 2N-706 RF	2.75
[ ]	1 ea. 4JX1C1132 Audio	1.95

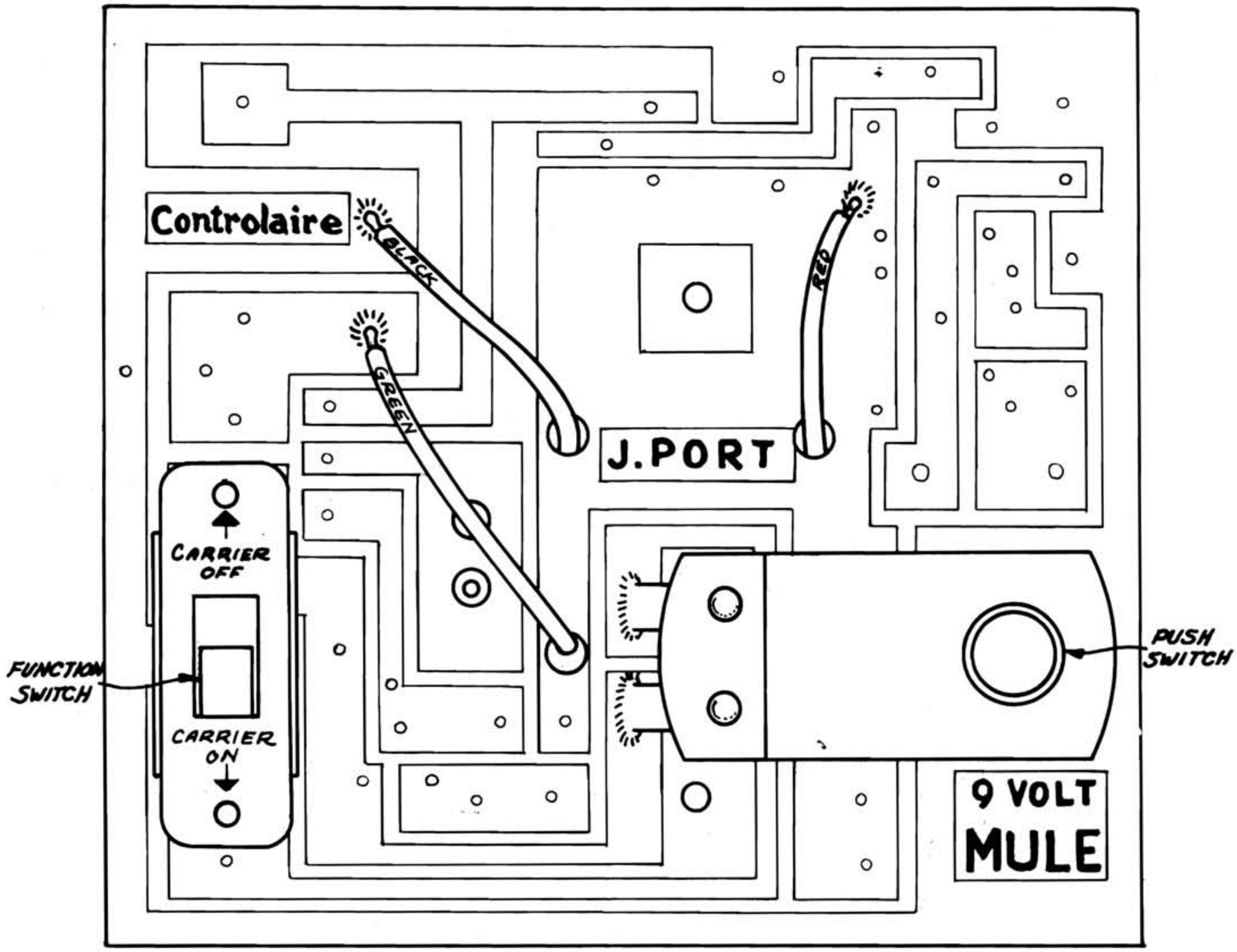
Misc. Parts

[ ]	1 ea. Etched Circuit Board	1.75
[ ]	1 ea. Operating Instructions	.15
[ ]	1 ea. Kit Assembly Tips	.10
[ ]	1 ea. Assembly Instructions	.25
[ ]	1 ea. Center Loaded Antenna	6.95
[ ]	1 ea. ½" Rubber Grommet	

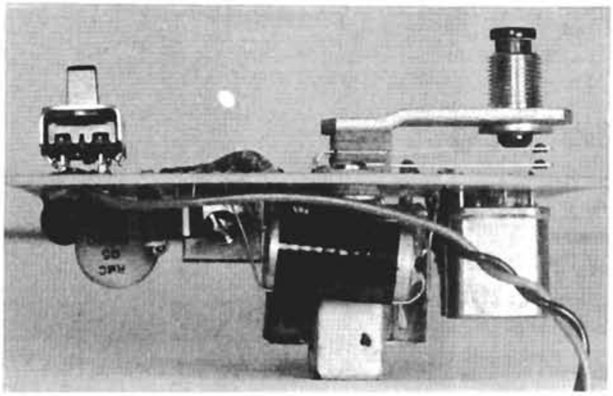
Capacitors

[ ]	2 ea. .02 MF Disc	.20
[ ]	1 ea. .01 MF Disc	.20
[ ]	1 ea. .05 MF Disc	.25
[ ]	1 ea. 100 MMFD Disc	.20
[ ]	1 ea. 50 MMFD Disc	.20
[ ]	1 ea. .47 MF Tubular	.95





BOTTOM VIEW - MULE   FIG. 1



World Engines Inc.

8206 Blue Ash Road   Cincinnati 36, Ohio

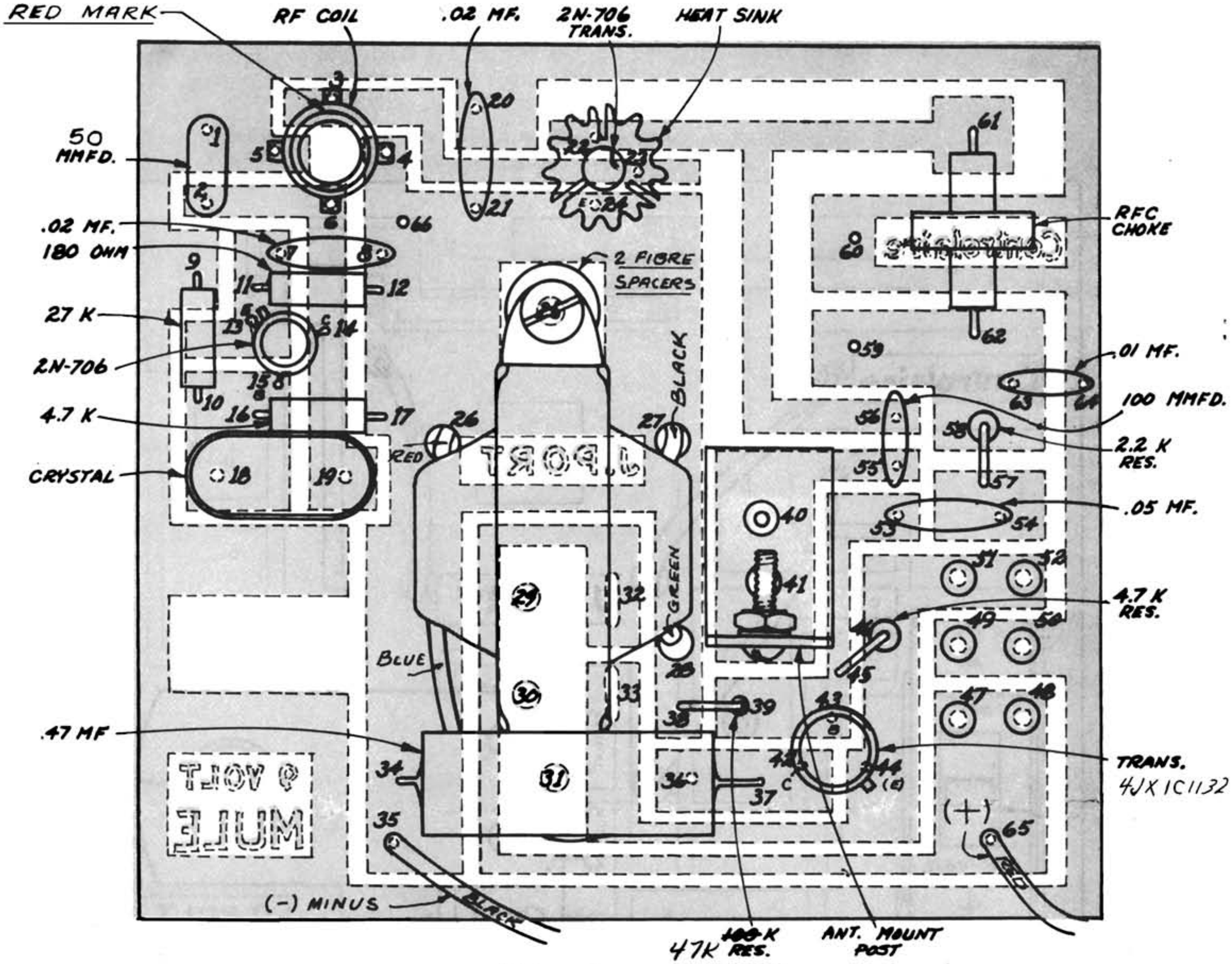
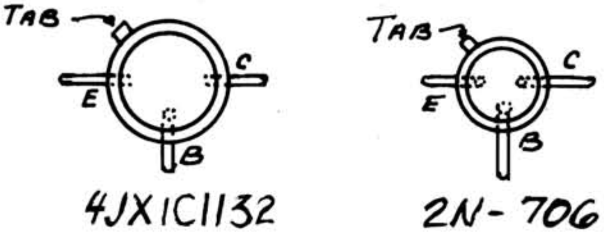


Fig 2 MULE



TRANSISTORS VIEWED FROM TOP WITH LEADS EXTENDING DOWN

Fig #3

INSTRUCTIONS

CONTROLAIRE "MULE" TONE TRANSMITTER

ALL TRANSISTORIZED

9 VOLT OPERATION

The MULE, although small, has a man-size wallop in reference to power output. Average radiated power is approximately 135 millawatts with a minimum specification of 100 millawatts before a transmitter is approved. This means the MULE will equal and in most cases surpass the output of the average tube type transmitter used in the past. Efficiency is due to several factors. One, the use of specially graded Silicon, RF transistors, the employment of a series tuned center loaded antenna and, last, the use of collector modulation. Collector modulation is quite important as average power will increase during modulation and not reduce as experienced with grid modulation of older tube type units. Modulation or tone frequency is approximately 600 C.P.S. The total power input for all stages is approximately 42 ma at 9v or about 380 millawatts. Of this power approximately 225 millawatts goes to the RF power amplifier which in turn supplies the antenna. A Class "C" citizens service station license is required to operate this transmitter.

PREPARING TRANSMITTER FOR USE

Use care when removing rear case cover as the case assembly screws and cardboard spacers are packed inside the case. Remove these items and prepare to install the antenna. Notice the small "L" bracket with attaching screw near the lower section of etched circuit board. This is the antenna attaching point. Insert the antenna carefully through the rubber grommet so as not to damage any of the internal parts then thread it firmly onto the antenna attachment screw. Notice that when fully collapsed your antenna only extends about seven inches above the case so generally leave it installed as it should present no transportation or storage problem.

The battery required is one (1) Eveready No. 276, Burgess D6, or Novel 306. It is installed in lower case compartment connecting the red wire snap to plus and black wire snap to minus. Use scrap cardboard or balsa blocks to take up unused space and to provide a tight battery installation.

OPERATING INSTRUCTIONS

Notice that the antenna is a center loaded unit and includes a coil assembly as part of the antenna. It is of primary importance when the antenna is extended that all slide elements are fully extended and especially that element just above the coil. This particular element, if not fully extended, can short out the coil and power output from transmitter will be reduced 90%. Sometimes on new antennas this one element may not slide freely through coil until it has been extended a few times. If yours appears to stick as it goes through the coil, rotate it slightly and this will free it. When fully extended this element will extend about $4\frac{5}{8}$" above coil.

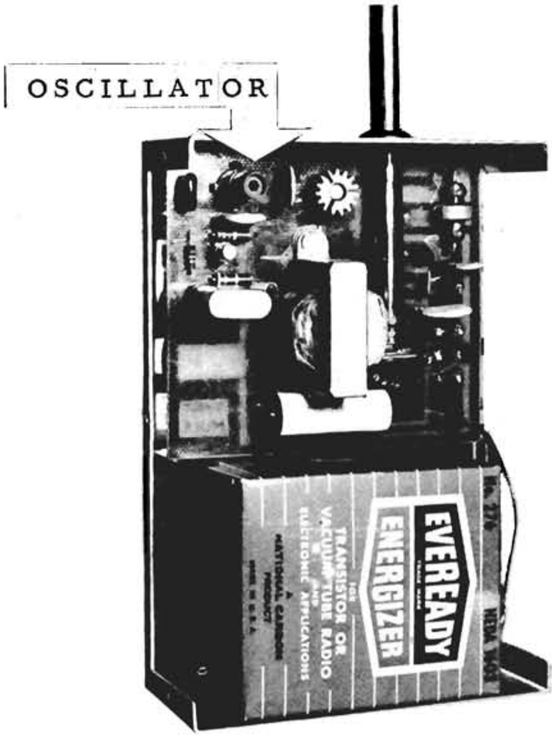
For maximum radiation of signal power the operator should grasp the transmitter case firmly with his bare hands. By doing this the operator becomes part of the antenna system (counterpoise) and maximum efficiency is achieved. Grasping the case loosely or the wearing of thick gloves reduces your body connections as part of the antenna system and power will be reduced. For maximum range to your receiver the antenna should be held vertical with respect to ground. When flying at an extreme distance do not point antenna at aircraft. This is brought to your attention for maximum efficiency - let it guide your operation.

SWITCH

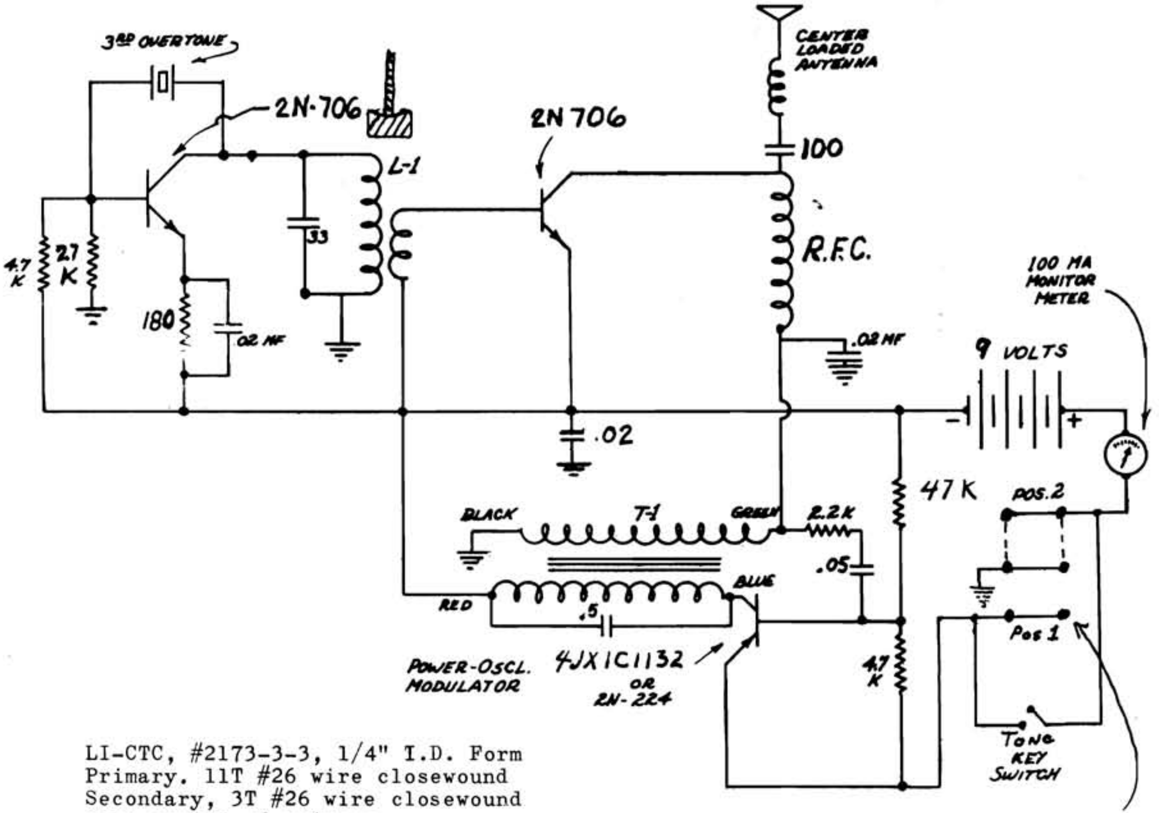
There are two switches on the front of the transmitter. One of these is a push button and the other is a slide switch. First about the operation of the slide switch. This is fundamentally a steady "carrier on" or carrier off" switch. When in the UP position the transmitter is basically off (no carrier), however, when the push button switch is actuated an instantaneous carrier and tone is produced. When the slide switch is in the DOWN position, this turns on a steady or continuous carrier and upon actuation of push button the steady carrier is again modulated with a tone. Normally when the transmitter is not in use the slide switch should be placed in the UP position so there is no drain on the batteries. Now, let's stop to consider this a minute. For the safest flying possible it is best to fly with a carrier on, however, this uses up batteries a little faster than to fly without a carrier on all the time. Flying without a carrier subjects your model airplane to a greater interference gamble than you would be taking by leaving the carrier on so if you feel you are flying in an interference free area you might try flying with the carrier off or with the switch in the UPPER position. Now, there is another advantage to flying without a carrier with some receivers. There are some receivers that have swamping tendencies so if you are flying up close to an airplane containing one of these receivers you should at least fly with your carrier off until your model airplane is far enough away so that it will not swamp and then you can turn the carrier ON switch on.

TUNING - only to be accomplished by persons having 1st or 2nd class commercial F.C.C. License.

Factory assembled transmitters have been tuned for maximum output and barring any physical damage should remain in tune indefinitely. Do not attempt to retune unless you are positive the tuning is at fault then be sure you understand the procedure. Equipment involved is a sensitive field strength meter, insulated tuning tool and 0-100 ma meter to measure the current drain from the batteries. Procedure is to place field strength meter at a point from the transmitter where a reading can be obtained actual distance will depend on sensitivity of meter. Install the 0-100 ma meter in the (+) lead from the batteries. Grasp transmitter case firmly and fully extend antenna - remember you are the counterpoise antenna. With slide switch in DOWN position (carrier on) notice the readings on the field strength meter and also the reading on the 0-100 ma meter. The field strength meter should indicate, however, its reading will be arbitrary. Current flow on the 0-100 ma meter should be approximately 30 to 40 ma. To check the tuning only one adjustment is involved. This is to the oscillator tuning slug and is one of adjusting the oscillator for best efficiency. There is no adjustment to the RF power amplifier as this is fixed tuned. To adjust the oscillator first unscrew the tuning slug so it is about halfway out of the coil. At this point the oscillator should be inoperative and no indication should be noted on field strength meter. Current flow on meter should be less than 10 ma. Starting with the slug at the halfway point of the coil, slowly readjust it into the coil and notice the exact point of adjustment where the current suddently jumps to the 30 to 40 ma level. The essence of proper oscillator adjustment is one of locating exact point where oscillator started or current suddenly increased, then pre-load the oscillator by turning slug one full turn more into the coil. This will allow current to rise about 4 ma above point of sudden increase and will insure oscillator starting every time it is keyed. At this point the oscillator should be operating properly and an indication should be noted on field strength meter. This completes adjustment to RF section of transmitter. To check operation of tone generator-modulator, depress push button switch and note if an increase of from 8 to 10 ma is registered on ma meter. If proper current use is noted a tone will be generated. It may be noted that the tone frequency of the transmitter may vary slightly as transmitter loading varies in operation. This is normal and will create no operational fault to your receiver.



CONTROLAIRE ALL TRANSISTOR "MULE"



LI-CTC, #2173-3-3, 1/4" I.D. Form
Primary. 11T #26 wire closewound
Secondary, 3T #26 wire closewound
over center of primary.

D.P.D.T. FUNCTION SWITCH. WHEN CONNECTED TO POSITION 1 - BOTH CARRIER & TONE ARE KEYED BY DEPRESSING TONE KEY SWITCH. WHEN IN POSITION 2 - STEADY CARRIER IS OMITTED AND TONE ONLY KEYED BY TONE KEY SWITCH.

T-1 - MODULATION TRANSFORMER
PRIMARY 500 OHM. SEC. 200 OHM.
CONTROLAIRE T-1

2N-706 - RF TRANSISTORS SELECTED.

CHANGE NOTICE - CONTROLAIRE 5

Due to tolerances involved in the supply of 155 T1, detector transistor, it is necessary that the condenser installed in holes 37 and 38 of step 15, be varied in actual capacitance value to match the particular transistor that is supplied in this kit. Since the capacitance will vary we have identified this condenser by painting a red mark on the body of the condenser. Its actual size will vary from .002 mf to .01 mf. However, this one has been selected for the 155 T1 supplied in this particular kit. Do not misconstrue this notice as a possible trouble point in earlier receivers as we select condensers to match any given batch of transistors.

THIS IS A CUSTOM CONTROLAIRE SERVICE TO THE KIT BUILDERS.

SUBSTITUTION NOTICE

CONTROLAIRE 5 RECEIVER KIT

1. A combination pair of (1) each 2N-508 and (1) each GC-4008 transistor may be substituted in your kit for the (2) each T-2515 transistors as called for by the instructions. If this has been done in your kit the 2N-508 installs in holes 25-26-27 as described by Step 22 and the GC-4008 installs in holes 4-5-6 as described by Step 23. Lead identification is the same as shown for the T-2515.

2. An 18 mmfd or 22 mmfd disc condenser may be substituted for the 20 mmfd disc condenser as called for by Step 14.

3. To increase the efficiency of the output transistor, install a 100 ohm resistor (Brown, Black, Brown) in holes 2 and 3 instead of the 470 ohm resistor as described in step 10. This is a design change and is not shown on the standard assembly instructions. Correct step 10, your circuit diagram, and kit parts list to show this change. No 470 ohm resistor is now used in this kit.

These substitutions will not effect operation of your completed receiver. It is done to allow an even production of kits when a specific part is not available and, therefore, make delivery to you

NOTICE

Our Service Department has notified us that 90% of the service problems on kits returned for repair is due to poor soldering by the kit builder. In most cases it is a complete disregard of the assembly steps that tells the builder to vigorously scrub his circuit board with steel wool before assembly. As supplied, the etched circuit board copper is protected with a thin layer of plastic. Although almost invisible, if not removed by steel wool it will create a soldering problem. Again, be reminded of the importance of this cleaning step. Do not disregard it.

CONTROLAIRE ELECTRONICS DIV., WORLD ENGINES, INC., CINCINNATI, O.

Controlaire 5

RELAYLESS SUPER - REGEN RECEIVER
OPERATING INSTRUCTIONS

The Controlaire "5" is a relayless all-transistorized receiver of advanced design. Its output is terminated in the use of a switching transistor that will operate an escapement direct without use of a relay. This feature allows for reduced size and weight thus making the receiver ideal for use in very small aircraft. Special design features eliminate all of the undesirable troubles that have been experienced in transistor receivers of the past. It will not swamp from strong transmitted signal conditions and has excellent noise rejection qualities. Last, but not least, it is fully temperature compensated to operate between 0° and 130° F. For operation the receiver requires a tone modulated signal from 500 to 1000 cycles per second. Factory assembled receivers are tuned to 26.995 mc, however, they can be retuned to match any transmitter from 26.995 mc to 27.255 mc. If your transmitter is at another frequency other than 26.995 be sure to retune the receiver before use.

TRANSMITTER REQUIREMENTS

For best results the transmitter should have a radiated RF output in excess of 75 millawatts and be tone modulated to a percentage of at least 75%. Tone frequency should be a desired 700 CPS, however, if from 500 to 1000 CPS it will give satisfactory operation. Average receiver sensitivity is about 4 micro volts so a transmitter below these specifications might create a range problem. For best results we recommend the companion Controlaire "Mule" transmitter. This is an all-transistorized unit and exceeds the specifications as given above.

BATTERY REQUIREMENTS

A common battery installation will operate both the receiver and your escapement. For very small aircraft use two 1½v pen cells connected to provide 3v. If aircraft is of a larger variety larger cells are recommended to give a longer life. For those who like the rechargeable feature of nickle cadmium batteries we suggest use of 3 cells to provide 3.6v. Cells should be at least 225 M.A.H. capacity and again larger if aircraft size permits. Minimum voltage for a safe flight range is 2v. If small pen cells are used, keep a check on their condition and replace after every 5 to 10 flights.

RECEIVER OPERATION

To operate receiver, refer to wiring diagram and connect escapement to the receiver and to batteries. The escapement can be either a self-neutral or compound type, however, your choice should have at least a 5 ohm coil resistance. Resistances up to 10 ohms are best recommended because of increased efficiency and lower battery drain. When receiver is turned on you might experience incidental operation of your escapement until transmitter carrier signal is turned on. This is somewhat normal and generally caused by random electrical noise or other citizens band signals that could be on the air. With carrier signal on all incidental operation will disappear. To operate receiver and escapement, key a tone signal and the receiver will respond. If trouble is encountered, double check your wiring to batteries or clearance adjustments to your escapement.

TUNING

Only one adjustment is involved and this is the rotation of the slug in the tuning coil assembly. One method of adjustment is to position your helper and transmitter about 100' distant. With transmitter antenna collapsed, key a tone signal and adjust the slug for operation of the escapement. If at this distance the escapement operates readily and will do so from a series of pulsed signals, have your companion hold a steady signal on then adjust slug both ways noting points where escapement released, then center slug in midway position. This will give you a fine tuning adjustment. Always use an insulated tuning tool when making adjustments to the tuning slug. Another tuning method is to remove antenna from transmitter to create a very weak signal condition. Hold transmitter near receiver antenna, key signal, then adjust tuning slug for operation of the escapement. As adjustment tends to give operation of the escapement, weaken signal by moving transmitter farther away from receiver antenna. Continue this process until a fine tuning peak can be obtained. If your transmitter is the 9v Controlaire Mule, antenna-less operation should be good from 3" to 10" from receiver antenna.

A third way to peak tune the receiver is to connect a flashlight bulb across the escapement terminals. The point here is to adjust tuning to give greatest brilliance when using weakest transmitted signal. Bulb may deactivate escap ment so remove it before flying.

TROUBLE-SHOOTING

Whenever trouble is experienced, such as loss of range, improper escapement actuation, always check condition of batteries and/or adjustment to escapement before assuming receiver is at fault. Battery voltage should be checked with receiver turned on and actuated with a signal. This creates a proper load condition.

GUARANTEE AND REPAIR

Guarantee - 60 days and is void if you dig into or modify the receiver.

Repair - Send your receiver Kit and 7.95 $~~2.5~~0 (our minimum) to Controlaire Division, World Engines, Inc., 8206 Blue Ash Road, Cincinnati, Ohio 45236. Tell us in a note what you think the trouble is. Do not make us guess.

For slow repair service - 3-4 weeks longer - 1. Ignore the above instructions. 2. Have your dealer send the receiver to us - this really slows things down as the dealers are busy and cannot drop everything to do your mailing for you and he may elect not to follow the above instructions. 3. Leave your name off of the returned receiver.

ASSEMBLY INSTRUCTIONS

Controlaire "5" Relayless

Super-Regen Tone Receiver

ALL TRANSISTOR 3 VOLT OPERATION

INTRODUCTION:

Again satisfaction on the flying field has prompted the production of another Controlaire receiver in kit form. This time it is the super-regen "5", a single channel relayless type receiver that has proven its worth by the testimonial of hundred of satisfied users. This combined with our own experience of factory assembly of the original units makes the receiver a natural for home construction. We now present the "5" in kit form. Assembly has been engineered to provide all needed information, however, one word of caution. The receiver is small and involves close soldering to a small circuit board. Do not rush the assembly but instead take your time and use common sense on the delicate work. Do so and your "5" will reward you with exacting service.

The instructions are presented in two separate manuals and a small pamphlet titled "Kit Assembly Tips". One manual is the standard "Operating Instructions" as supplied with factory assembled units and the other manual is the "Assembly Instructions" which you are now reading. It is of primary importance that before any asssembly work is started that you initially read all three of these items to gain a preliminary understanding of all information involved.

As you study the manual you will notice that assembly is outlined by the step by step procedure and large pictorials which identify all parts and their exact placement to the circuit board. To understand the assembly procedure take notice of the main pictorial, Fig. 2. This is the pictorial about which the assembly text is centered. Notice that this is a top view of the receiver chassis and that all componants are assigned specific hole numbers. The shaded area represents the etched copper circuit pattern and although on the underside of the board, the same pattern can be recognized on the receiver board by holding it up to a light source where the pattern will show through. By using the light on the actual receiver board specific holes can be identified by association with the pattern or individual copper lands as shown in the pictorial.

Assembly of parts to the circuit board is quite conventional. Resistors and most other parts are mounted flush or upright as directed, however, if any specific positioning is required it will be mentioned in the step in which it is installed. As each part is installed bend its leads over slightly to hold it in position and then, after soldering, clip off the excess lead about 1/16", from the circuit copper.

Prelminary Notes

After you have studied the pictorials and initially read all of the instructions, unpack your kit carefully and check each part as identified on the check list. By doing this you will become familiar with parts appearance that will help you during assembly. After the check has been made, group the parts, resistors, in one pile, condensers in another, until parts are generally sparated for easy identification.

Occasionally, we may have to substitute a part to allow an even production of kits when a specific part is not available. This is done to prevent a delay in filling your order and in no way will the substitution effect normal operation. If this has been done in your kit a note, "Parts Substitution", will be included for your identification.

The use of the "Ungar Soldering Pencil" equipped with 37½ watt heat element and small chisel pointed tip is considered mandatory in the construction of this kit. Similar irons may be used but none larger and of higher heat. The work on the etched circuit board is somewhat delicate so let a word to the wise be sufficient. If you do not have the small iron it should be purchased at your local radio or hardware store.

Common tools required are a small pair of dykes (wire snippers), long nose pliers, screw driver, penknife, file, pad of steel wool. Other driver, penknife, file, pad of steel wool.

Start construction by referring to the assembly steps. During each step refer to the pictorials for necessary parts location and solder the lead of each part as it is installed. Place a check mark in the space provided after completion of each step. Good luck and may your experience be a pleasant one.

ASSEMBLY INSTRUCTIONS

As parts are installed to the circuit board, bend over the leads only enough to hold the parts in place, then solder, unless otherwise noted in text. Do not flush bend lead to the circuit copper as, if removal is necessary, it cannot be done without damage to the part. After soldering, clip off excess leads about 1/16" from circuit copper.

(✓) 1. Assembly is started by first cleaning the circuit board copper so soldering may be done easily and with the least amount of heat. To do this involves a certain procedure as the board is supplied to you with the tuning coil pre-installed. The best way is to lay the board flat against your work bench with the coil overhanging the edge. Hold board firm then scrub vigorously with steel wool until copper is bright and shiny. After cleaning, blow away any wool residue that may have entered coil form or remaining on circuit board.

(✓) 2. Sometimes in the factory operation of cementing the coil to the board epoxy cement clogs some of the circuit board holes near the coil. Inspect your board and if any are clogged use a straight pin to clear.

(✓) 3. Notice that the wire leads on the tuning coil are twisted together for a short length. This is done for shipping purposes and before the leads are inserted into circuit board they must be untwisted and any excess kinks removed. Be careful not to unwind the coil. Insert bottom lead into hole 61 and top lead into hole 60. The coil wire is of a type where the heat of the soldering operation removes the insulation. Soldering will be somewhat stubborn but as the insulation melts away you will note the proper flow of solder on both the wire and circuit copper. Be sure the wires are properly soldered.

(✓) 4. Inspect the interstage transformers and note that one side is marked with either a RED dot or the letter "S". This means that the leads extending from this side of the transformer are of the secondary winding. Insert one transformer with secondary leads going into holes 50 and 51 and the other two leads into holes 55 and 54. Push transformer flush to circuit board with frame tabs going into holes 52 and 53. Bend tabs to secure transformer but do not solder to circuit copper.

(✓) 5. Using same procedure to identify secondary leads, insert the remaining transformer with secondary leads going into holes 41 and 42, and other leads into holes 43 and 44. Tabs go into holes 40 and 45 are bent over and again not soldered.

(✓) 6. Three identical resistors, 1 K ohm (brown, black, red) are installed in this step. One in holes 12 and 15, another in holes 13 and 16 and a third in holes 7 and 8.

(✓) 7. Install a 100 ohm resistor (brown, black, brown) in holes 32 and 33.

(✓) 8. Install a 1.5K ohm resistor (brown, green, red) in holes 48 and 49.

(✓) 9. Install a 15K ohm resistor (brown, green, orange) in holes 46 and 47.

(✓) 10. Install a 470 ohm resistor (yellow, violet, brown) in holes 2 and 3.

(✓) 11. Install a 4.7 ohm resistor (yellow, violet, red) in holes 11 and 14.

(✓) 12. Install the RFC choke in holes 17 and 18. To identify, the RFC choke is a small resistor-like component that is wound with fine wire.

(✓) 13. Install a 4 MMFD disc condenser in holes 62 and 63.

(✓) 14. Install a 20 MMFD disc condenser in holes 58 and 59.

(✓) 15. Install a .01 MF disc condenser in holes 37 and 38.

(✓) 16. Install a 62 MMFD disc condenser in holes 30 and 31.

(✓) 17. Install a .02 MF disc condenser in holes 56 and 57.

(✓) 18. Two identical .01 MF disc condensers are installed in this step. One in holes 28 and 29, another in holes 9 and 10.

(✓) 19. Notice the polarity markings on the body of the 15 MF electrolytic condenser. This identifies polarity of leads. Install this condenser with plus lead going into hole 23 and minus lead into hole 24.

(✓) 20. Install the 15 MF electrolytic condenser with plus lead going into hole 20 and minus lead in hole 19.

In the following steps the transistors are installed. To identify the leads, refer to Fig. 3. All transistors should be installed with bottom surface spaced about 3/16" from surface of circuit board. Do not flush mount.

(✓) 21. Identify the leads of the 155-T1 transistor. Install it with the collector going into hole 34, base in hole 35, and emitter in hole 36.

(✓) 22. Install a T-2515 transistor with collector going into hole 25, base in hole 26 and emitter in hole 27.

(✓) 23. Install a T-2515 transistor with collector going into hole 5, base in hole 4 and emitter in hole 6.

(✓) 24. Install a 2N-229 transistor with collector going into hole 22, base in hole 39 and emitter in hole 21.

(✓) 25. Strip ⅛" insulation from one end of a 10" length of white, black and red wire. From the underside, or copper side of the board, solder the white wire to copper land identified by hole 5. Solder the red wire to land at hole 6. Black wire to land at hole 19. After all three wires have been soldered, route them through hole 1 which acts as a strain relief.

(✓) 26. Strip ⅛" insulation from one end of a 30" length of wire (antenna). Insert this end of wire through hole 64 so both wire and insulation extend through hole for about ¼". Bend down bared end of wire and solder it to copper land containing **hole 64.**

(✓) 27. Screw tuning slug into tuning coil until it is about flush with top of coil form. If slug appears very tight rotate it back and forth to gradually loosen its threads.

At this point assembly of the receiver is complete. To check it out for operation, refer to the "Operating Instructions".

CONTROLAIRE "5"

PARTS CHECK AND PRICE LIST

Wiring

[✓] 3 ea. 10" length, No. 26 Stranded Red, Black, White	.10
[✓] 1 ea. 30" length No. 26 Stranded (antenna)	.05

Resistors

[✓] 1 ea. 100 ohm (Brown Black, Brown)	.12
[✓] 1 ea. 470 ohm (Yellow, Violet, Brown)	.12
[✓] 3 ea. 1K ohm (Brown, Black, Red)	.12
[✓] 1 ea. 4.7K ohm (Yellow, Violet, Red)	.12
[✓] 1 ea. 1.5K ohm (Brown, Green, Red)	.12
[✓] 1 ea. 15K ohm (Brown, Green, Orange)	.12

Capacitors

[✓] 1 ea. 4 MMFD Disc	.25
18mm [✓] 1 ea. 20 MMFD Disc	.25
[✓] 1 ea. 62 MMFD Disc	.25
[✓] 3 ea. .01 MF Disc	.25
[✓] 1 ea. .02 MF Disc	.25
[✓] 2 ea. 15 MF Electrolytic	.65

Transistors

[✓] 1 ea. 155-T1 RF Detector	1.95
[✓] 2 ea. T-2515 Audio	1.50
[✓] 1 ea. 2N-229 Audio	.90

Transformers, Coils, Chokes

[✓] 1 ea. 12 Micro Henry RF choke	.35
[✓] 1 ea. RF Coil Assembly and Tuning Slug	.90
[✓] 2 ea. Interstage, 10K to 1K Transformers	1.20

Misc. Parts

[✓] 1 ea. Etched Circuit Board	1.95
[✓] 1 ea. Kit Assembly Tips	.10
[✓] 1 ea. Assembly Instructions	.25
[✓] 1 ea. Operating Instructions	.15
[✓] 1 ea. 24" length 60/40 Solder	.10

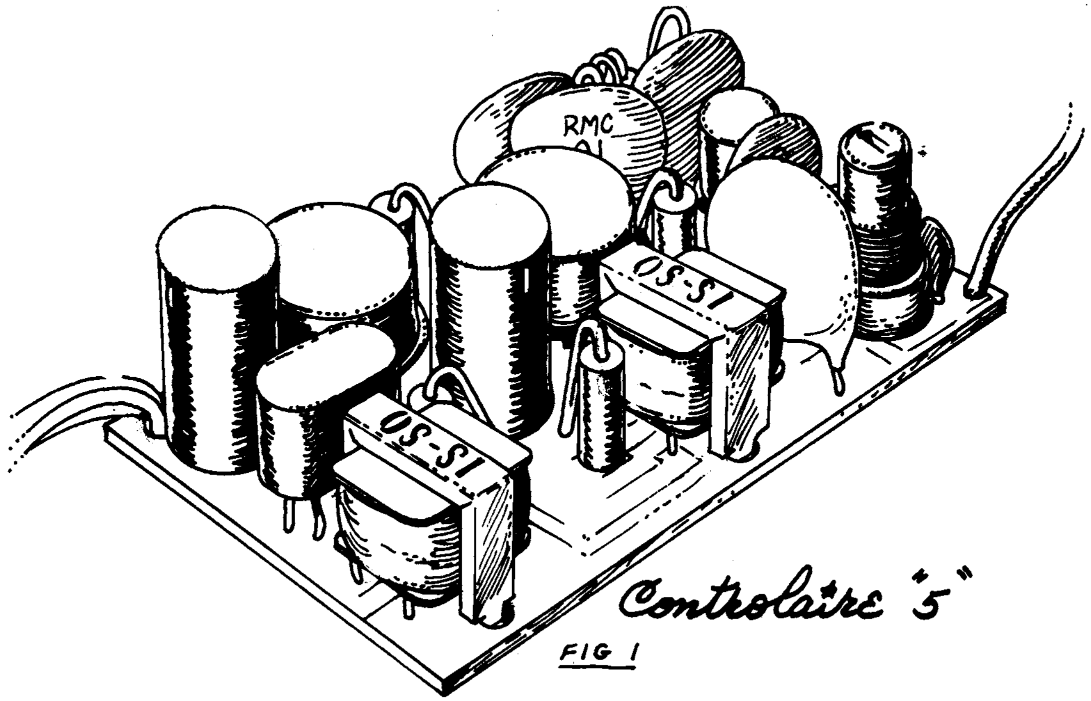


FIG 1

TROUBLE-SHOOTING TIPS

Occasionally, someone experiences trouble in the completion of his receiver. Whatever your problem, first review your assembly steps to insure proper assembly. Secondly, check all solder joints and the board for possible solder shorts between copper lands. If this reveals no mistake, the following procedure can be applied to isolate the trouble to a particular stage.

The receiver involves four stages. One, a super-regen detector, followed by three stages of audio amplification. When operating properly at idle, the detector 155-T1 generates a noise signal commonly referred to as super-regen "hiss". The hiss is then fed by transformer coupling to the first audio stage (T-2515) where it is amplified. From here by means of transformer coupling to the second audio (2N-299) where it again is amplified but changed in the output of this stage from an AC noise signal to a DC current level This is done by the 15MF filter capacitor. From here the DC current level is direct coupled to the fourth stage (T-2515) where it is amplified as a DC level only to actuate the escapement.

The idle hiss as described above and directed through the stages, is of a very low amplitude. As a a simple means of isolating trouble a common high immpedance earphone can be used to listen to the signal. To use the earphone as well as other equipment you might have, oscilloscope, etc., connect one lead to the negative battery connection and with a .01 to .05 MF condenser in series with the other lead touch it to the following points. First, to copper land containing hole 60. See Fig. 4 circuit diagram and note this is output point for the 155-T1 detector stage. A very slight hiss should be heard. If not, it indicates detector is inoperative. If OK, next touch probe lead to land hole position 25. This is output of first audio (T-2515) and hiss should be substantially louder. Next to land hole position 22. This is output of second audio (2N-229). This time the noise will be weaker but still audible due to filtering of the 15 MF capacitor. As to hiss in last stage as touched to land hole position 5, there is barely an audible sound due to filter action of this stage. Actually, if any problem was involved in last stage it could be only a defective transistor or open or shorted escapement as these are the only two componants involved. The point in the earphone test was tracing the hiss noise from its origin, the detector through the stages to determine proper operation of the stages. If not present at detector, stop and check components of this stage. Probable cause aside from assembly mistakes, is 155-T1 transistor or open or shorted coils, choke or transformer. The same would apply if hiss disappeared at a succeeding stage. From this point in trouble-shooting location of an exact cause of trouble may involve use of V.T.V.M. measuring the voltage points as shown on the circuit diagram. If you have such an instrument you probably know how to use to isolate a component trouble. One last point. Sensitivity of the detector 155-T1 is controlled by value of resistor installed in hole 13 and hole 16. To increase sensitivity, decrease value no more than 30% and vice versa.

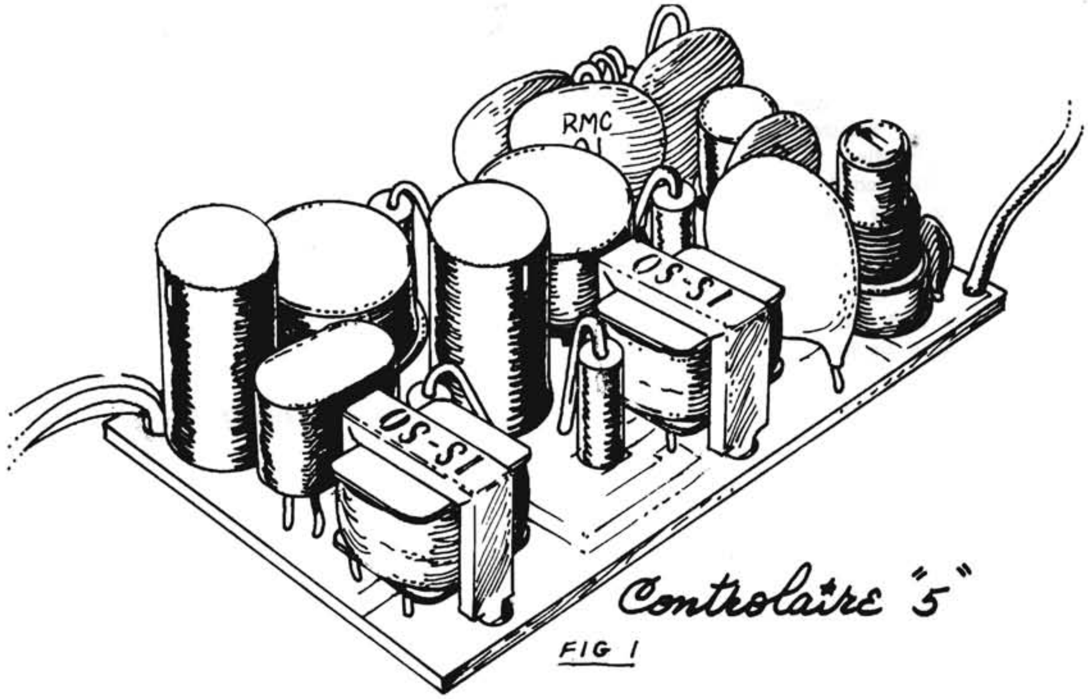


FIG 1

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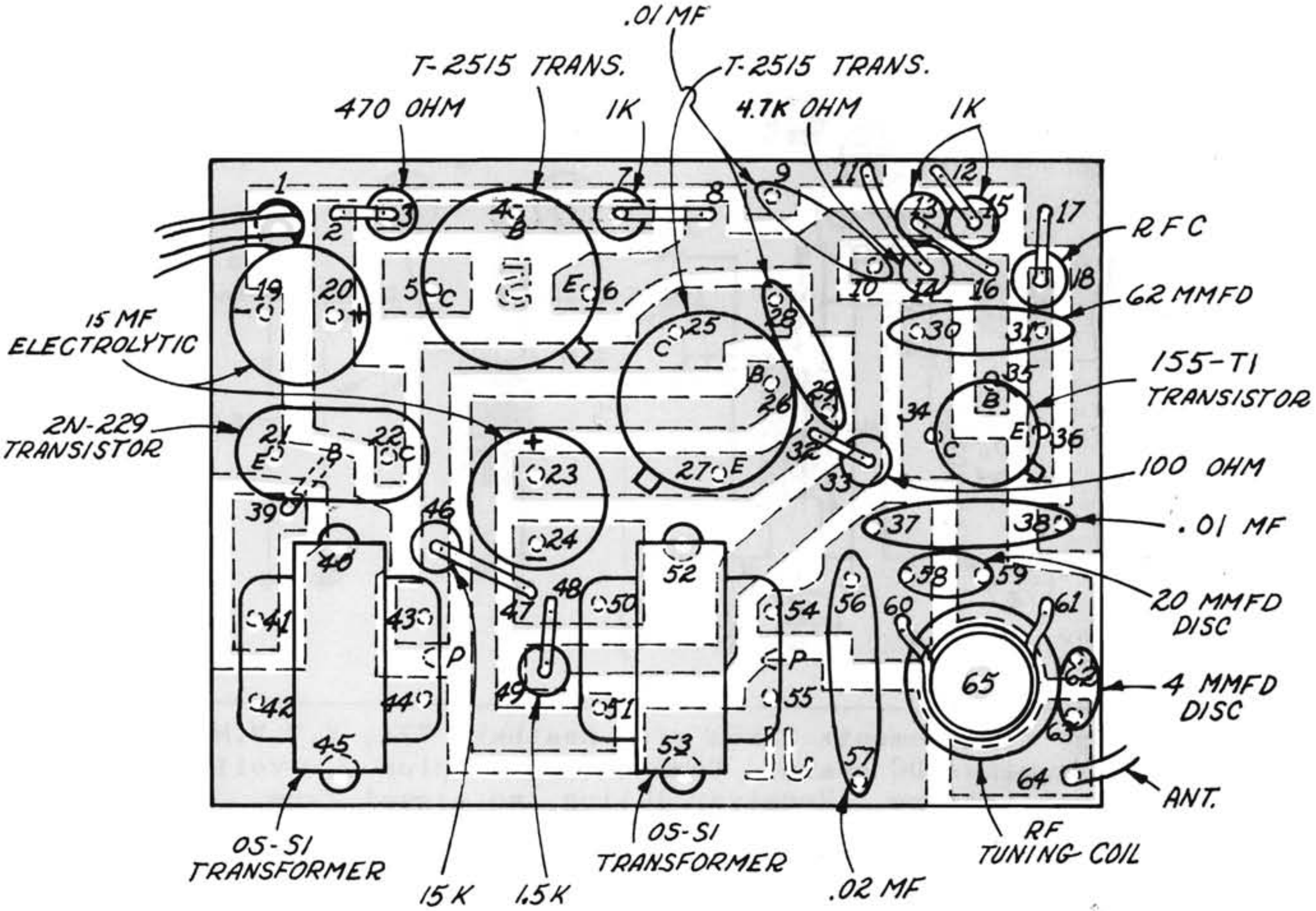
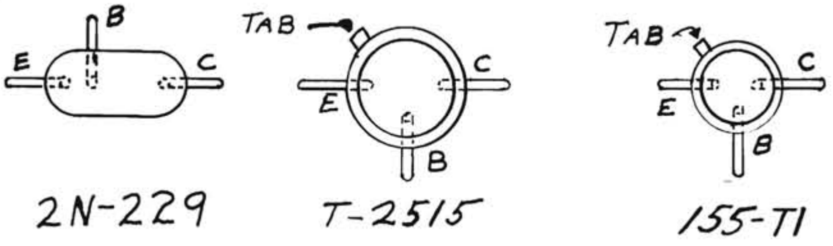


FIG 2

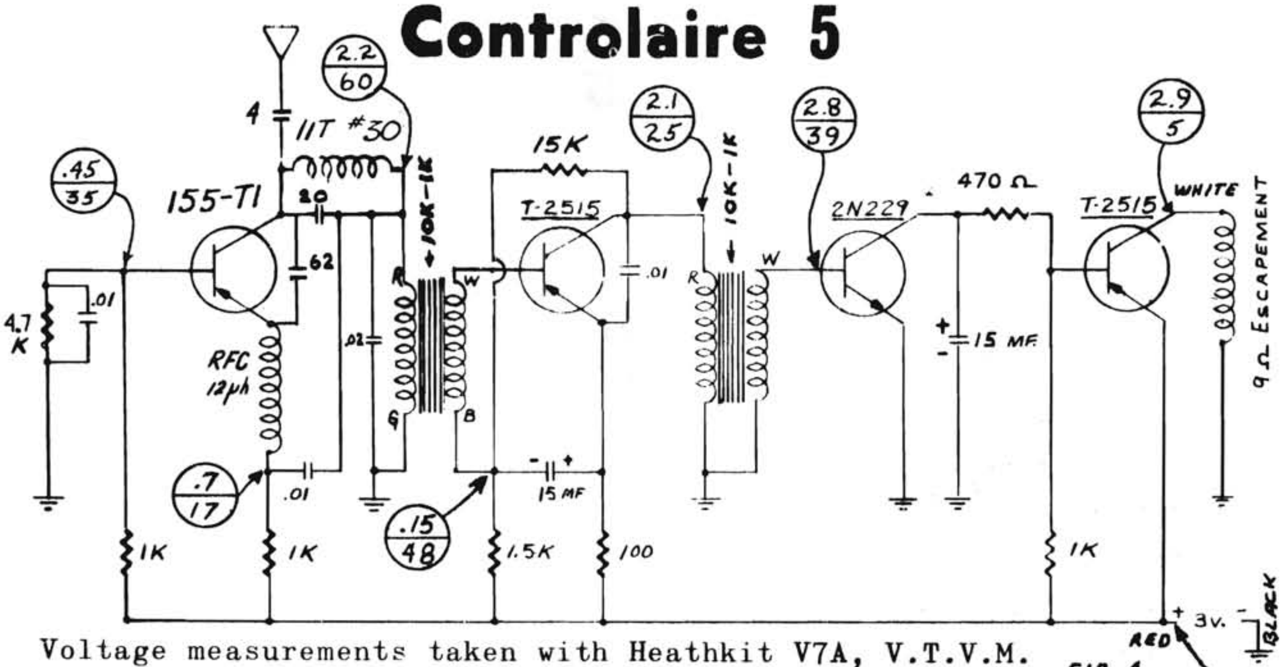
Controlaire "5" RELAYLESS RECEIVER



TRANSISTORS VIEWED FROM TOP WITH LEADS EXTENDING DOWN

FIG 3

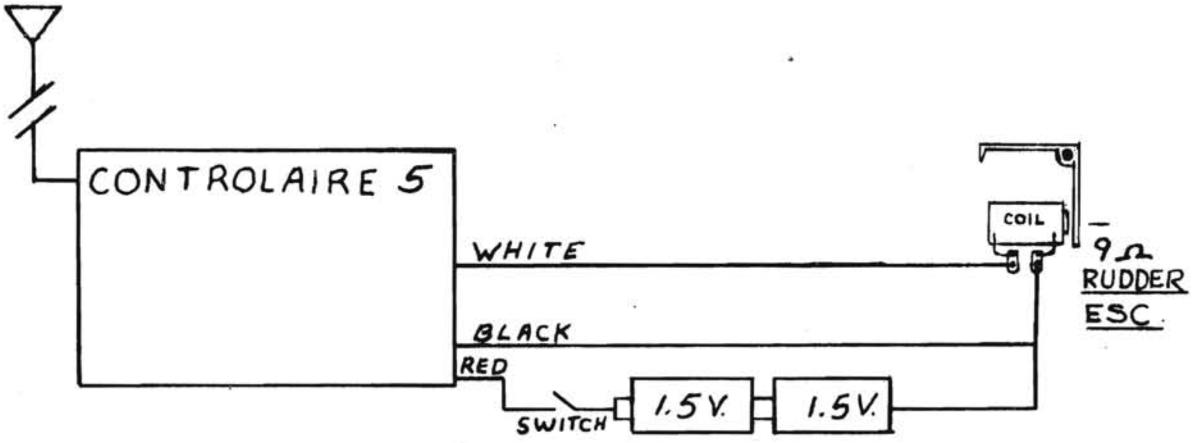
Controlaire 5



Voltage measurements taken with Heathkit V7A, V.T.V.M. 5 volt, minus DC scale. Common lead to plus 2.9 volts receiver battery. Receiver idling, no signal from transmitter. Note divided circles on diagram, top No voltage measured, lower No is circuit board hole that identifies copper land to which place DC probe. Normal measurement can vary plus or minus 20% due to component tolerances.

FIG. 4

Common Lead V.T.V.M. 2.9v



Pencells Shown - For Ni-Cad Operation Use 3.6 Volts

FIG. 5

Wired Connections

In other than etched circuit board work, do not rely on just a solder bond to hold a part secure to its connection. All wiring and component parts leads should be wrapped or crimped to their respective terminals, before soldering, to create a good mechanical joint. Parts such as condensers, resistors, chokes, etc., should have their excess lead length trimmed so they can be installed in a direct point to point manner between terminals as shown in the pictorials. Bare leads that could possibly short to one another should be insulated with spaghetti tubing.

Etched Circuit Board

If your kit was supplied with an etched circuit board, the copper pattern will have to be cleaned just prior to its use. To protect the copper laminate during storage the photo resist material, used during its manufacture, has been left on the cooper. To clean, scrub the board vigorously with steel wool until the copper is bright and shiny. After cleaning, refrain from excessive handling of the copper laminate as oils from the hands will initiate corrosive action. Soldering to the board is close work, but it is not necessarily delicate. Extreme amounts of heat should be avoided to prevent loosening of the copper laminate from the board. After all parts are installed or during the assembly steps, coat all bare copper areas not yet soldered with a light coat of solder to protect the board in use. If you have cleaned your board to a sparkle finish, the solder will flow very easily and only a minimum of heat need be used. When assembling parts to a very small circuit board, a magnifying glass can be a very useful tool.

Polarity Of Components

When you are installing electrolytic capacitors and diodes you must observe the polarity of the part. These parts have plus and minus terminals and you must connect them according to their polarity correctly in the circuit.

Controlaire Division

World Engines Inc. 8206 BLUE ASH ROAD CINCINNATI 36, OHIO

CONTROLAIRE

KIT ASSEMBLY TIPS

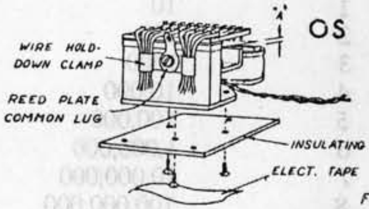


FIGURE 7

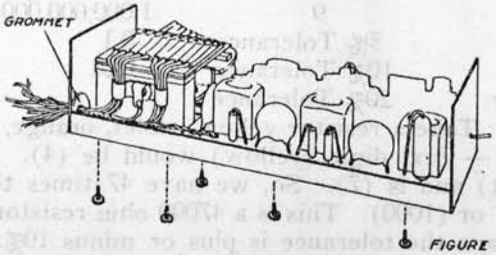


FIGURE 8

by JACK PORT

Kit Assembly Tips

Never start actual kit construction until you have first read all of the instructions. This applies to expert as well as novice as complete familiarization will minimize the possibility of a mistake. All of us have the human factor so let this be your guide.

Parts (Component) Identification

The best way to identify the parts is by reference to the pictorials. The resistors have color bands on them for identification. Different bands specify different values of resistance. The silver and gold bands are tolerance marks and they should not be confused with the identification strips.

Color	**Digit**	**Multiplier**
Black	0	1
Brown	1	10
Red	2	100
Orange	3	1000
Yellow	4	10,000
Green	5	100,000
Blue	6	1,000,000
Violet	7	10,000,000
Gray	8	100,000,000
White	9	1,000,000,000
Gold	5% Tolerance	0.1
Silver	10% Tolerance	0.01
No Color	20% Tolerance	

Example: Take a resistor yellow, violet, orange, silver. Refer to chart — first digit (yellow) would be (4). Second digit is (violet) and is (7). So, we have 47 times the multiplier (orange) or (1000). This is a 47000 ohm resistor. The silver band means the tolerance is plus or minus 10%.

Components other than resistors have the values marked on them or the component can be identified by comparison of physical features with the pictorials sketches provided with your kit.

Soldering

Probably the greatest limiting factor in the proper assembly of this kit is your ability to make a good soldered connection. Soldering is not difficult but a few basic facts should be known. In all radio work only special radio type solders should be used. These contain a rosin type flux within the core of the solder and are noncorrosive. In your kit there is supplied a quantity of 60/40 "Ersin Multicore" or "Kesters Resin Five" solder. The 60/40 means solder composition of 60% tin and 40% lead and melts at a relative low heat. If you should run short and cannot obtain the above solder, be sure you at least obtain a rosin core product. Do not use acid core solders or paste type flux as, by doing so, serious corrosion can result and voids any guarantee extended on this kit. As a soldering iron, the size should be limited to the delicacy of the work involved. For all etched circuit board work, (small Rx for instance) the "Unger Soldering Pencil" equipped with 37½ watt heat element and 1/8" chisel pointed tip is best recommended. For larger work involving more mass (not on receivers), an iron such as the "Wen, Model 100" soldering gun would be best but, in all cases, limit the heat to not more than 100 watts. Excess heat is very damaging. Components such as resistors, condensers, transistors, can even change electrical value if overheated as well as boiling the actual solder joint that ruins its adhesive qualities. The best procedure to follow when making a soldered joint is to apply the tip of the iron to the joint, then apply solder so the flux and solder can melt into the joint at the same time. The iron should be applied only long enough for the solder to flow into and around the joint, then removed. Keep in mind that the flux within the core of the solder is equally important as solder and heat to make a good connection. The flux cleanses the joint and allows for good solder adhesion. Even though a joint and component are initially clean, the application of heat starts an immediate oxidation that tends to dirty the joint, if no flux is available to cleanse the joint, a poor connection will result. Never attempt to solder a joint by carrying molten solder to the joint on the tip of your iron. In the process of doing so, the flux disappears in smoke and none is left for the joint. A good solder joint has a smooth shiny appearance. Here are some tips to help you recognize a poor joint. If excessive heat or insufficient flux is being used, an immediate oxidation will take place creating a condition where the solder adheres more to the tip of the iron than to the joint. This produces a frosty tipped joint, the tip being formed as the iron is pulled away. To correct, use less heat and more flux. Another condition is one of insufficient heat, this produces a bumpy frosted joint but usually one of flux flooding. Both joints are mechanically and electrically insecure and should be avoided.

Inspection of Component Leads

Inspect the leads of all resistors, condensers, coils, etc., for a condition of cleanliness before being used. Although parts are purchased new they do tend to oxidize in storage. If a lead is initially dirty, the problem involved is one of solder adhesion. If you try to solder a dirty lead you will probably use too much heat. This only aggravates the problem. You get the excess heat by holding the iron on longer than you would if the leads were clean to start with. If lead cleanliness is doubtful on any component, scrape it lightly with a pen knife to insure its condition for proper soldering.